Natural capital

Agricultural land: nitrogen balance

Indicator	EU indicator past trend	Selected objective to be met by 2020	Indicative outlook of the EU meeting the selected objective by 2020
Gross nutrient balance in agricultural land: nitrogen		Manage the nutrient cycle in a more sustainable way (nitrogen) — 7th EAP	
Overall, the agricultural nitrogen balance shows an improving trend. However, on average, the EU still has an unacceptable level of nitrogen losses from agricultural land to the environment and further efforts are needed to manage the nutrient cycle for nitrogen sustainably in the EU			

The Seventh Environment Action Programme (7th EAP) calls for further efforts to manage the nutrient cycle in a more sustainable way and to improve efficiency in the use of fertilisers. Currently, nitrogen losses from agricultural land, namely from fertiliser use, to the environment have a significant negative impact on biodiversity and ecosystems. These nitrogen losses to the environment in the EU have decreased considerably over the period examined (2000–2013), with expected positive effects on soil, water and air quality and, consequently, on biota and ecosystems. The causes of these improvements include nitrogen management practices; of these, the most important are changes in fertiliser application techniques. However, on average, the EU still has an unacceptable surplus of nitrogen in agricultural land in view of the consequent losses to the environment, and further efforts are needed to manage the nutrient cycle for nitrogen in a sustainable way in the EU.

For further information on the scoreboard methodology please see Box I.1 in the EEA Environmental indicator report 2016

Setting the Scene

The 7th EAP (EU, 2013) calls for further efforts to manage the nutrient cycle in a more sustainable way and to improve efficiency in the use of fertilisers. Excessive nutrient losses affect soil, air and water quality, have a negative impact on ecosystems and have the potential to cause significant problems for human health. This nutrient pollution also results in significant economic losses and increased costs for society (e.g. in relation to tourism and recreation, human health and drinking water treatment). If not applied correctly (e.g. taking account of weather conditions, stage of crop growth, dosage, etc.), fertilisers cause excess nutrients to be released to the wider environment by run-off into surface water (AIRS_PO1.9, 2016).[1] or leaching into groundwater. Eutrophication caused by excess nutrients can result in increases in weeds and algae, reduced oxygen levels and subsequent biodiversity loss. These impacts can be reduced by balancing nutrient inputs with the outputs of the agricultural system (i.e. nutrients contained in grazed and harvested crops) in order to limit nutrient losses to the environment. Both nitrogen and phosphorus are important sources of nutrient pollution, although, nitrogen losses are currently the most significant nutrient losses, in particular from agricultural production that have a negative impact on ecosystems. Therefore, this briefing focuses on the nitrogen balance in agricultural land.

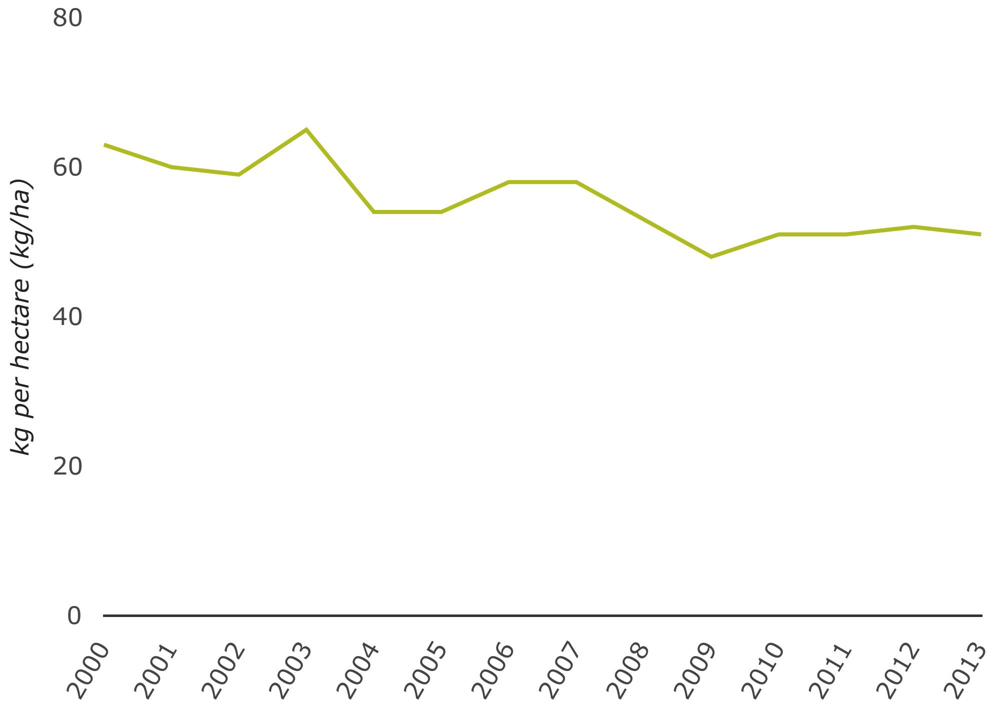
Policy targets and progress

There are no environmental acquis objectives that match the 7th EAP objective of managing the nutrient cycle in a more cost-effective, sustainable and resource-efficient way. Nevertheless, several directives relate to the nutrient cycle. The EU Nitrates Directive (EU, 1991) aims to reduce water pollution by nitrates from agricultural sources and prevent pollution of ground and surface waters. To achieve this, the Directive sets legally binding maximum concentrations of nitrates in drinking water, limits the annual application of nitrogen fertiliser and livestock manure and designates periods during which nitrogen application is prohibited. There are several other EU directives that are relevant to the impact of excessive nutrient use in agriculture, namely the EU Water Framework Directive (EU, 2000) through its legal obligation to protect and restore the quality of all inland and coastal waters across Europe, the Directive on Sewage Sludge (EU, 1986) through its regulation of the use of sewage sludge in agriculture, as well as legal instruments of the Common Agricultural Policy (CAP), which encompass environmental requirements (cross-compliance) and targeted environmental measures that form part of the Rural Development Programmes. Achieving a gross nutrient balance that implies acceptable losses to the environment, although not a stated aim of these directives, is a key contributor to achieving some of the aims of these directives.

In the period between 2000 and 2013, the gross balance between nitrogen added to and removed from agricultural land in the EU showed an improving trend (Figure 1), meaning that the gap between inputs and outputs is closing and, therefore, the overall nitrogen balance is improving. The surplus of nitrogen applied to agricultural land fell by about 19 %, from 63 kg per hectare in 2000 to 51 kg per hectare in 2013 (Figure 1).

The causes of these improvements include nitrogen management practices; of these, the most important are changes in fertiliser application techniques (Eurostat, 2015) as a result of the implementation of specific measures of the Common Agricultural Policy and EU legislation.

Figure 1. Gross nitrogen balance, EU



Data sources: Eurostat. Gross nutrient balance on agricultural land

Assessing whether the nitrogen cycle is managed sustainably holds many challenges, and determining a sustainable level of nitrogen balance is not trivial. A zero balance for nitrogen might not be realistic because of the inevitable losses of nitrogen to air (mainly ammonia) and water (mainly nitrate). The main focus should be on reducing losses to the minimum level possible — for instance through resource-efficient agricultural practices — and on reaching a better understanding of acceptable losses of these nitrogen compounds to the environment. This can be estimated through a critical loads (inputs) approach, which is a quantitative estimate of the upper limit of pollution exposure at which harmful effects to the environment (water, ecosystems, species) can be avoided. Work is ongoing to improve our understanding of critical loads for the EU's ecosystems (EEA, forthcoming).

When considering critical loads of nitrogen in surface water and in air with respect to biodiversity (habitat quality) in 2010 (EEA, 2015a; EEA, forthcoming), the amounts of nitrogen applied to the system were found to still substantially exceed acceptable inputs and related losses, despite the decreasing trend in the nitrogen balance. This is confirmed by the reported eutrophication pressure on the EU's protected species and habitats (EEA, 2015b) (AIRS_PO1.7, 2016)[2], (AIRS_PO1.8, 2016).[3]

Reductions in fertiliser use and livestock numbers are helping to improve the nitrogen balance, but agriculture remains an important source of nitrogen in surface waters (EU, 2010). Agriculture, particularly runoff from agricultural land, is typically contributing 50 – 80 % of the total nitrogen load in European surface waters (EEA, 2005), affecting nitrogen levels in freshwater (EEA, 2015c) and transitional, coastal and marine waters (EEA, 2015d). Mineral fertilisers deliver on average slightly more than 45 % of the nitrogen input in the EU, while nearly 40 % comes from organic fertilisers, i.e. manure (EEA, forthcoming).

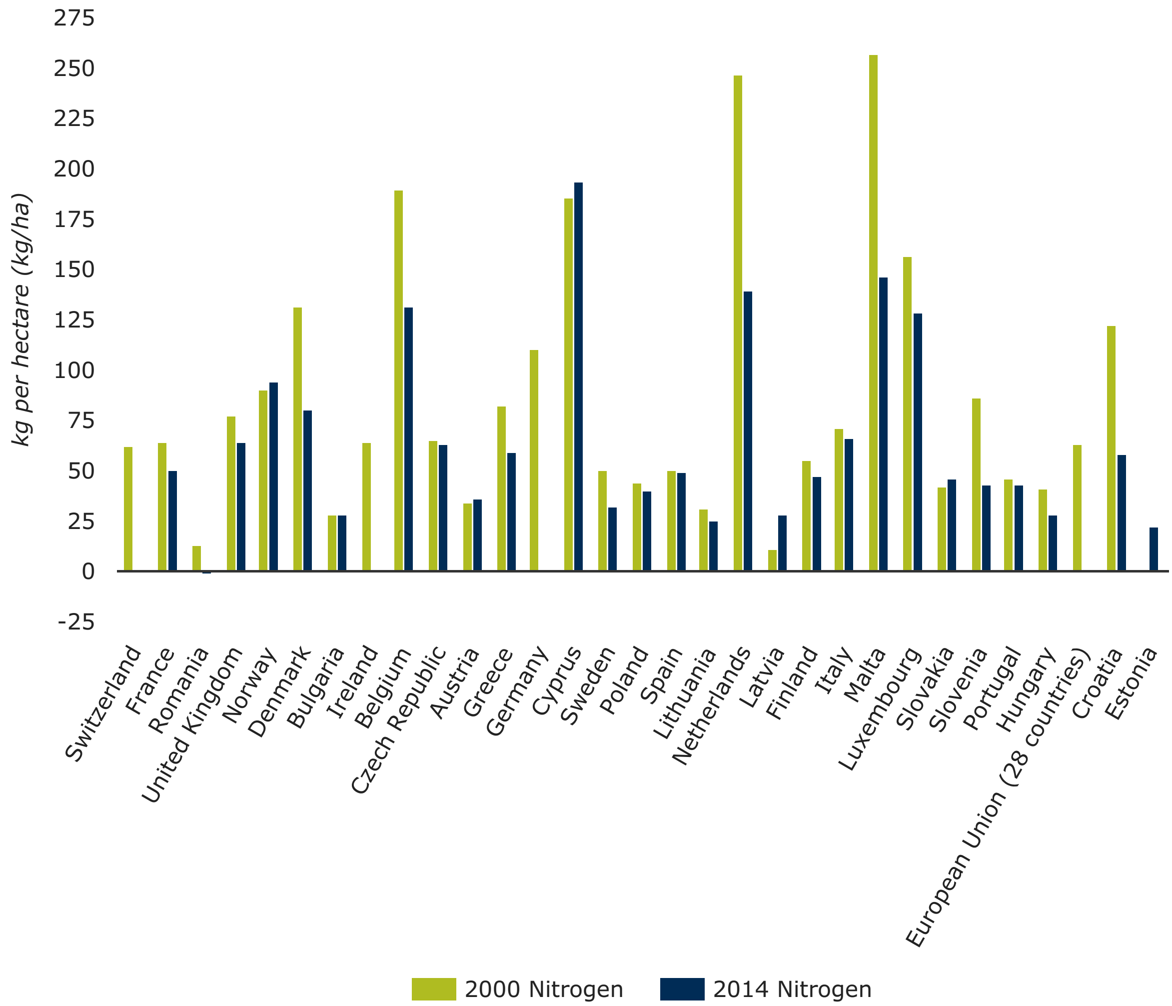
Within the EU, mineral fertilisers are applied to agricultural soils mainly as straight nitrogen fertilisers in the form of ammonium nitrate. Since the 1990s, although the total agricultural surface area has decreased, the area of certain crops that receive high application rates of ammonium nitrate, such as wheat and oilseed rape, has increased. Nitrogen in mineral fertilisers is particularly soluble to facilitate uptake by crops, but this also makes it susceptible to run-off following heavy rainfall and to leaching to groundwater (Eurostat, 1999). In countries with intensive livestock production, critical losses to water and air (with related effects on biodiversity) occur predominantly as a result of excess manure inputs (EEA, forthcoming). Manure inputs, in particular, contribute to ammonia (NH_3-N) emissions.

In conclusion, overall, the agricultural nitrogen balance shows an improving trend. However, on average, the EU still has an unacceptable surplus of nitrogen in agricultural land in relation to losses to the environment, so further efforts are needed to manage the nutrient cycle for nitrogen in a sustainable way in the EU.

Country level information

Agricultural nitrogen balances show an improvement from 2000 to 2013 in the majority of European countries, with the exception of some countries: Austria, Czech Republic, Latvia, Lithuania, Norway, Poland, and Slovakia (Figure 2).

Figure 2. Gross nitrogen balance, by country



Note:
Due to methodological issues or missing data, balances have been estimated by Eurostat for: Malta, Belgium, Denmark, Cyprus, Italy, Spain, Luxembourg, France, Lithuania, Latvia, Bulgaria, Romania, and Greece. The results of these countries can only be regarded as a rough indication of the gross nitrogen balance.

Data sources: Eurostat. Gross nutrient balance on agricultural land

In most countries, implementation of the Nitrates Directive and other agricultural improvements has tended to stabilise or reduce nitrogen inputs, potentially reducing environmental pressures (Eurostat, 2015).

Although decreasing in most Member States, agricultural nitrogen surpluses are still high in some parts of Europe, in particular in Western Europe and in some Mediterranean countries. Even in countries with low national averages, there can be regions with high loadings, depending on agricultural intensity, including livestock density.

Outlook beyond 2020

Future trends in the use of mineral fertilisers will depend on a number of factors, in particular on future EU agricultural and environmental policies. According to the Food and Agriculture Organization of the United Nations (FAO), while fertiliser use is set to decline marginally in western Europe until 2018, it is set to increase in central and eastern Europe, mainly because of an increase in ammonia production capacity (ammonia is used to produce fertilisers) in eastern Europe (FAO, 2015), which is likely to increase fertiliser production, with the subsequent risks of excessive nutrient application.

Some of the actions likely to influence nutrient use in EU countries result from further uptake of agri-environmental measures that focus on the reduction of inputs. These include measures to further implement the Nitrates Directive and increased use of soil sampling and fertiliser advice programmes to encourage the trend towards optimal application.

About the indicator

The indicator estimates the potential surplus (or deficit) of nitrogen in agricultural land. It calculates the balance between nitrogen added to an agricultural system and nitrogen removed from the system annually in kilograms of nitrogen per hectare of agricultural land. The input side of the balance counts mineral fertiliser application and manure excretion as well as atmospheric deposition, biological fixation and biosolids (compost, sludge and sewage) input, while the output side of the balance represents the removal from grassland (grazing and mowing) and the net crop uptake (removal) from arable land. The gross nitrogen balance takes an 'extended soil' surface or 'land' surface as the system boundary, meaning that it also includes the nitrogen losses from animal housing and manure management (e.g. storage) systems.

The data used are partly based on experts' estimates of various physical parameters for the country as a whole. Differing assumptions mean that the balances should only be considered as consistent within a country and that comparison between countries should be made with caution. There may also be large regional variations within a country, and therefore national figures should be interpreted with care. In fact, gross nitrogen balance calculations are available up to NUTS 3 level (NUTS is the Nomenclature of Territorial Units for Statistics). Further downscaling is possible but introduces additional uncertainty in the data. Nevertheless, higher resolution data provide an insight into the variations and intensity of regional and local nitrogen losses, and subsequent negative impacts on regional and local ecosystems and biodiversity.

References

EEA, 2005, Source apportionment of nitrogen and phosphorus inputs into the aquatic environment, EEA Report No 7/2005, European Environment Agency.

EEA, 2015a, 'Exposure of ecosystems to acidification, eutrophication and ozone (CSI 005)' (http://www.eea.europa.eu/data-and-maps/indicators/exposure-of-ecosystems-to-acidification-3/assessment-2) accessed 28 October 2016.

EEA, 2015b, State of nature in the EU, EEA Technical report No 2/2015, European Environment Agency (http://www.eea.europa.eu/publications/state-of-nature-in-the-eu) accessed 28 October 2016.

EEA, 2015c, 'Nutrients in freshwater (CSI 020)' (http://www.eea.europa.eu/data-and-maps/indicators/nutrients-in-freshwater/nutrients-in-freshwater-assessment-published-6) accessed 28 October 2016.

EEA, 2015d, 'Nutrients in transitional, coastal and marine waters (CSI 021)' (http://www.eea.europa.eu/data-and-maps/indicators/nutrients-in-transitional-coastal-and-3/assessment) accessed 28 October 2016.

EEA, forthcoming, 'Critical loads of nitrogen' (http://www.eea.europa.eu/publications).

EU, 1986, Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture (OJ L 181, 4.7.1986, p. 6–12)

EU, 1991, Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (OJ L 375, 31.12.1991, p. 1–8).

EU, 2000, Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (OJ L 327, 22.12.2000, p. 1–23).

EU, 2010, The EU Nitrates Directive, Publications Office of the European Union (http://ec.europa.eu/environment/pubs/pdf/factsheets/nitrates.pdf) accessed 2 May 2016.

EU, 2013, Decision No 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 'Living well, within the limits of our planet' (OJ L 354, 28.12.2013, p. 171–200).

Eurostat, 1999, 'Nitrogen in agriculture' (http://ec.europa.eu/agriculture/envir/report/en/nitro_en/report.htm) accessed 28 October 2016.

Annual Indicator Report Series (AIRS)

Eurostat, 2015,Sustainable development in the European Union. 2015 monitoring report of the EU Sustainable Development Strategy, Eurostat Statistical books, Publications Office of the European Union, Luxembourg, ISSN 2443-8480.

Eurostat, 2016, 'Gross nutrient balance in agricultural land (t2020_rn310)' accessed March 2016.

FAO, 2015, World fertiliser trends and outlook to 2018, Food and Agriculture Organization of the United Nations, Rome, ISBN 978-92-5-108692-6.

AIRS briefings

1. AIRS_PO1.9, 2016, Surface waters
2. AIRS_PO1.7, 2016, EU protected species
3. AIRS_PO1.8, 2016 EU protected habitats

> Environmental indicator report 2016 – In support to the monitoring of the 7th Environment Action Programme, EEA report No30/2016, European Environment Agency